CAN FEEDLOT LAMBS BE FED ECONOMICALLY TO HEAVIER WEIGHTS?

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16. Abstracts

Economic analysis was applied to an experiment designed to determine the characteristics of feedlot ram and ewe lambs carried to heavier than normal weights under alternative ration energy densities. The study concluded that net returns can be increased by feeding ram lambs to weights 10 to 40 pounds heavier than the normal 90- to 110-pound weight range depending upon feed cost levels, feed ration, and lamb valuation method. High-energy density diets provided the highest net returns for both ram and ewe lambs. Three feed price levels and three lamb valuation schemes were also tested.

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SUMMARY AND CONCLUSIONS

This study explores the economic feasibility of feeding lambs to heavier slaughter weights as one means of increasing consumer supplies of lamb. Results indicate that it can be profitable. Rams fed a high-energy diet under simulated price and cost conditions generated profits at weights of 154 pounds and above. But with this diet, highest net returns were obtained at 143, 121, and 110 pounds liveweight for low, medium, and high feed price levels, respectively. These weights are above the 90- to 110-pound slaughter weight range typical in the industry.

Optimal ewe lamb slaughter weights were generally about 11 pounds lower than ram weights and profits per ewe lamb were lower. While profits for ewes fed the high-energy diet were obtained at weights up to 143 pounds assuming low feed prices, net returns were maximized at 121, 99, and 99 pounds for the low, medium, and high feed price levels, respectively.

The high-energy density diets resulted in improved feed efficiency (energy required per unit of gain) for ram lambs, compared to the low-energy diet. Ewe lambs, however, exhibited little change in feed efficiency as one diet was compared to another. Energy consumed was shown to be an increasing function of weight for both sexes, with the result that about a fivefold increase in feed energy was required to put on a pound of gain at 143 versus 66 pounds liveweight. Value per lamb increases at a decreasing rate as weight increases and is overtaken by the increasing costs, resulting in first increasing net returns per lamb, then decreasing net returns as lamb weight increases.

Feed efficiency was higher for ram than ewe lambs at each feed ration and weight level. Dressing percentages and quality grades were lower for rams, but their effect on lamb value was not enough to offset the ram's superior feed

efficiency. Therefore, rams were generally more profitable than ewes for all rations tried and at all slaughter weights.

For both sexes, the high-energy density diet was superior to other diets in net returns per lamb because: (1) costs per unit of metabolizable energy were lower, (2) feed efficiency was improved (especially for rams), (3) growth rate was increased, thus reducing time in the feedlot, and (4) lamb value at any weight was increased as a result of higher dressing percentages and quality grades. Under medium feed price levels and assuming no discount for above-normal slaughter weights, net returns per ram on the high-energy diet were $9.19 at their optimal weight of 121 pounds, which required 112 days in the feedlot. Under these conditions, net returns per ewe were $3.79 at their optimal weight of 99 pounds, which required 99 days in the feedlot.

The analysis is based on an Agricultural Research Service experiment conducted to determine the characteristics of lambs fed to heavier than normal slaughter weights. A 2 x 3 factorial arrangement involving 441 ram and ewe lambs in three ration energy density treatments with two replications was conducted in 1976 and early 1977. Lambs were weighed and their feed consumption was determined at 28-day intervals. Lambs within each pen were serially slaughtered and carcass measurements were taken. The heaviest group averaged about 154 pounds liveweight at slaughter. Data were analyzed, and regression equations were estimated to determine how growth, feed consumption, quality grade, yield grade, and dressing percentage were related to time in the feedlot, sex, and diet. Price and cost data were added to determine the profitability of feeding lambs to heavier weights on various feed rations.

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NEW AGENCIES

On January 1, 1978, the Economic Research Service, the Statistical Reporting Service, and the Farmer Cooperative Service were merged into one agency--the Economics, Statistics, and Cooperatives Service.

This report was written prior to a recent reorganization which placed the Agricultural Research Service (ARS) in a newly created Science and Education Administration (SEA). All references to ARS in this manuscript, therefore, relate to SEA.

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by

Virden L. Harrison and John D. Crouse

INTRODUCTION

A recent plan called "Blueprint for Expansion" was established by segments of the sheep industry 1/ to revitalize the industry and increase lamb production. The plan cited a three-pronged goal for each year of the next decade: (1) increase sheep numbers by 5 percent, (2) increase lambing percentage weaned by 2.5 percent, and (3) increase lamb slaughter weight by 1.5 percent. In this study, the economic feasibility of one of these goals--producing lambs to heavier slaughter weights--is explored as one means of increasing consumer supplies of lamb and increasing producers' net returns.

Generally declining U.S. sheep production spurred the sheep industry to prepare the Blueprint. Sheep and lamb numbers on U.S. farms have declined every year since 1960. Their numbers peaked at 56.2 million head in 1942, declined to 33.2 million in 1960, and further dropped to 12.7 million in 1977. Sheep and lamb numbers have declined an average of 7.4 percent per year for each of the last 5 years (11, 12).2/ Most of the decline has been in the West where many small- and some large-scale producers have discontinued sheep production.3/ From 1964 through 1974, the number of sheep producers in the West decreased by more than 34,000 or about 40 percent. Of these 34,000, 87 percent had produced fewer than 300 stock sheep per farm (7).

Gee and others recently cited several major factors in the decline of the western sheep industry: (1) shortage of hired labor, (2) low lamb and

1/ Associations cooperating in formulating the Blueprint were the American Sheep Producers Council, the National Lamb Feeders Assn., the National Wool Growers Assn., and the Sheep Industry Development Program, Inc.
2/ Underscored numerals in parentheses refer to items in References.
3/ The 17 Western States produce about 80 percent of the U.S. stock sheep and lambs and, in 1976, had about 43,000 farmers and ranchers producing sheep.

wool prices, (3) predation losses, (4) age of owner, and (5) greater profitability of other livestock (7). Most of these problems still exist, although since 1974, farm prices for lambs have improved somewhat relative to cattle prices.4/

Several factors indicate that the U.S. sheep industry may be in serious trouble. Lamb has disappeared from many grocery stores and, where it does appear, it is generally priced higher than comparable beef and pork cuts. Many slaughter plants have discontinued slaughtering lambs due to lack of sufficient numbers to make the operation profitable. Consequently, lamb producers are forced to find marketing outlets at more distant points, thus increasing the costs of marketing sheep. Also, with fewer sheep slaughter points, the competition has lessened with the result that producers are in a worse position to bargain for the selling price. In 1974, 10 plants slaughtered 90 percent of the U.S. lambs. Feeding of lambs by packers has increased during the period of decreasing supply to insure themselves a more steady supply of lambs for slaughter. This, too, tends to reduce the producer's bargaining position. However, 2 regional telephone auctions have been established in recent years (and more are being sought) to broaden the selling market and attract more bidders on lambs.

Production of heavy market lambs could substantially increase quantity and efficiency of lamb production and reduce the processing costs per pound of lamb meat. Liveweights of sheep and lambs sold for slaughter have been gradually increasing over time, reaching a high of 109 pounds in 1976. Weights were 86 pounds in 1940, 95 in 1950, 98 in 1960, and 104 in 1970 and 1975 (10, 12). Results of this study will show that slaughter weights can continue to increase, especially for ram lambs on high-energy diets, and remain profitable at normal price and cost levels. But the product, if it is to be desired by the consumer, must have acceptable palatability devoid of offensive flavor and aroma. Lambs tend to develop objectionable odor and flavor as their weights increase. These traits vary by breed type, ration fed, sex, season of the year, form of feed, and stage of maturity. Therefore, in developing a heavy market lamb technology, the enterprise must be managed for highly desirable, efficiently produced carcasses. Heavy market lambs are, at times, docked in price, depending on the buyer and his perceived demand for carcasses of various sizes.

As the weight of a lamb increases, the percentage of fat in the carcass tends to increase; for ram lambs, the fat often becomes soft and oily, especially for those on high-energy diets. Objectionable odors have been observed in carcasses from ram lambs fed a high concentrate diet and weighing 155 pounds or more liveweight at the U.S. Meat Animal Research Center at Clay Center, Nebraska. Data from the literature are inconsistent as to the characteristics of heavy- and lightweight slaughter lambs. But, in general, heavy lambs are reported to have higher dressing percentages, higher quality

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4/ Yearly average farm prices per cwt for choice slaughter lambs (San Angelo) and choice slaughter steers (Omaha), respectively, were $35.10 and $42.80 in 1973, $37.00 and $35.60 in 1974, $42.10 and $32.30 in 1975, and $46.90 and $33.70 in 1976 (13, pp. 11, 25).

and yield grades, and possibly higher flavor, juiciness, and tenderness scores. Few studies have characterized lambs at very heavy weights (i.e., above 155 pounds). Misock and others reported data from 72 ram lambs slaughtered at about 123, 159, and 172 pounds and found no significant differences from the lightest to the heaviest rams in flavor, juiciness, and aroma; but tenderness declined significantly with higher weights. However, the middleweight group was inconsistent with the other two groups in several carcass traits, making the results inconclusive (9). Several studies report favorable carcass characteristics for lambs up to at least 132 pounds (1, 2, 3, 8, 9).

DESIGN OF EXPERIMENT

The experiment on which this study is based involved 441 lambs in a 2 x 3 factorial arrangement with two replications. It was conducted at the U.S. Meat Animal Research Center (2). Two pens (about 38 lambs per pen) of ram lambs and two pens of ewe lambs were used on each of three ration energy levels (table 1). Lambs within each pen were serially slaughtered at random in three slaughter groups. Weights and feed consumption data were recorded at about 28-day intervals.

Table 1--Composition of rations for heavy lamb production

Item	Energy level		
	Low	Medium	High
		Percent	
Ingredient:			
Alfalfa, dehydrated	89.32	51.60	14.30
Corn grain	8.41	33.40	59.40
Soybean meal	0	8.80	18.20
Limestone	0	.52	2.60
Sodium tripolyphosphate	1.00	.76	.55
Ammonium chloride	1.25	1.20	1.20
Chelated trace minerals	.01	.01	.01
Durabond	0	3.75	3.75
Dry matter	93.70	92.67	89.86
Composition (dry matter basis):			
Crude protein	19.41	18.29	21.03
		Megacalories per pound	
Digestible energy 1/	1.253±.016	1.350±.015	1.539±.010
Metabolizable energy 1/	1.011±.016	1.106±.014	1.298±.010

1/ Based on digestion trial of 5 ram lambs per ration.

Lambs used in the experiment were produced by mating purebred Suffolk rams to one-half Finnish Landrace ewes, were born from March 12 to April 21, 1976, and were weaned at 35 to 42 days of age. Lambs were placed on trial after about a 30-day postweaning period and were fed ad libitum by self-feeders. Measurements taken after slaughter included hot and cold carcass weight; quality and yield grades; fat color, firmness, and thickness; kidney and pelvic fat weight; leg conformation; and scores for buckiness and maturity.

A second, more extensive experiment using 138 ram and ewe lambs of the same breeding and age was conducted concurrently with the above experiment. These lambs were individually limit-fed the same low-, medium-, or high-energy diets as the above experiment and slaughtered in five groups. In addition to the carcass measurements cited above, more intensive cooler data were collected in cooperation with the University of Wyoming including marbling; lean color and texture; overall conformation; complete retail product fabrication; and chemical analysis of protein, moisture, ether extract, and ash. Finally, taste panel data on 57 of the lambs were collected to determine flavor, tenderness, juiciness, aroma, and overall acceptability. Results of this experiment are not reported in this paper, but because of the similarity of breed type and feed rations, some information from it is used to strengthen the present analysis.

Biological results of the above experiments are presented in detail in (2). This paper presents a portion of the biological data as they relate to growth, feed consumption, and value-determining factors such as dressing percentage and quality grade. To these data are added price and cost data in order to analyze the results from an economic standpoint.

PRICING AND COST ASSUMPTIONS

Three feed price alternatives were assumed for this analysis--low, baseline, and high (table 2). Principal feed ingredients were dehydrated alfalfa, corn grain, and soybean meal. Baseline feed prices approximate the normalized average over the past several years and represent what the authors view as the "most likely" levels to be achieved over the next few years. Low and high price levels are deviations of 15 to 25 percent from the baseline. They are not extremes; they have been achieved in recent years. They do provide a range for analytical comparisons. Prices for the principal ingredients are assumed to move in the same direction relative to one another (that is, under the high scenario, the prices for each ingredient are high).

Since this study involves comparisons of lambs under three ration metabolizable energy levels, the value of each ration was calculated on the basis of cost per megacalorie of metabolizable energy ($/Mcal ME). Under all three feed price scenarios, the cost per Mcal ME was lower for the higher energy rations (table 2). Thus, the cheapest energy source was the high-energy ration.

Table 2--Feed price assumptions for low-, medium-, and high-energy rations assuming three price levels

Item	Feed price level		
	Low	Baseline	High
Principal feeding ingredient price:	Dollars per cwt		
Alfalfa, dehydrated	3.80	4.50	5.20
Corn, grain	3.33	4.20	5.00
Soybean meal	6.00	8.00	10.00
Ration energy level:	Dollars per Mcal ME 1/		
Low	.04173	.04926	.05675
Medium	.04019	.04845	.05646
High	.03352	.04412	.05235

1/ Mcal ME = megacalories of metabolizable energy.

Total production costs per lamb equals feed cost plus lamb purchase price ($23.00) 5/; plus $2.50 which represents veterinary, sales expenses, repairs, fuel, and miscellaneous; plus $0.0433 times days on feed which represents labor, investment, and interest charges. These values were obtained from recent published and unpublished USDA estimates and experiment station reports with certain adjustments by the authors to reflect typical confinement lamb operations.

Lamb value depends upon several factors including weight, quality and yield grade, dressing percentage, level of maturity, season of the year, level of demand for lambs of various weights, amount of wool, and lamb buyer. Prices offered for lambs and the pricing method vary considerably among buyers. For this reason, several alternative lamb valuation schemes were calculated, three of which were used in this analysis. Most buyers take into account the percentage of lambs in the Choice and Prime quality grades, the average dressing percentage, and the percentage showing buckiness characteristics. Also, many offer a reduced price for lambs weighing more than 110 or 115 pounds. The lamb pricing schemes included in this analysis are as follows: (1) $50.00 per cwt adjusted by $1.00 for each dressing percentage below or above 51, (2) $50.00 per cwt adjusted as above and adjusted by $0.80 for each quality grade unit below or above 11.5, 6/ and (3) $50.00 per cwt adjusted as (2) above with a reduction in value of $20.00 per cwt for weight in excess of 110 pounds. Thus, under scenario (3), lambs averaging 130 pounds with average dressing percentage of 48.8 and average quality grades of 11.2 (Medium Choice) would be valued at 1.30 (50.00 - 2.20 - 0.24) - 4.00 = $57.83 per lamb.

5/ This value assumes $48.00 per cwt or $23.00 for a 48-pound feeder lamb.
6/ Quality grade scores are as follows: 9 = High Good, 10 = Low Choice, 11 = Medium Choice, etc.

RESULTS

Data showing pen means of liveweight, feed consumption, and feed efficiency at each weigh period are shown in table 3. Since the treatments were replicated, these data are the weighted averages of the pen weights and feed consumption for each of the weigh periods, which were at about 28-day intervals.

Regression equations were generated from the data in the experiment to smooth the results and allow interpolation between data points. A smoothing of the results also allows a more accurate selection of economic optima to be discussed below. Pen means at each weigh period were used to generate equations for growth and feed consumption for each sex and dietary energy treatment (table 4). Equations are exponential of the form $Y = aX^b$, where Y is liveweight (growth equation) or megacalories of metabolizable energy (feed consumption equation) and X is days on feed. Results in table 4 also show equations for dressing percentage, quality grade, and yield grade. These, too, were regressed on time as the independent variable with data points at three slaughter dates for each treatment.7/

Regression equations for feed consumption, dressing percentage, and quality grade could just as easily have used liveweight as the independent variable rather than days on feed. However, the accuracy of the estimated coefficients would not have been improved greatly, because liveweight, as well as the above variables, is so highly correlated with time as shown by the high r^2 values in table 4.

Using the above equations for each sex and ration energy treatment, tables 5 and 7 for ram lambs and tables 6 and 8 for ewe lambs were generated to show various lamb characteristics at 11-pound liveweight increments. Weights in the tables range from 66 to 154 pounds for rams and 66 to 143 pounds for ewes.

Feed Costs and Efficiency

For rams, high-energy rations resulted in fewer days and megacalories of energy to reach a given weight. Thus, cumulative feed efficiency was improved for rams fed the high-energy diets (table 5). For ewes, high-energy rations also resulted in fewer megacalories of energy required to reach a given weight (table 6). For both sexes and all three rations, feed efficiency decreased markedly as weight increased; but the high-energy rations were superior in this regard and rams were superior to ewes at all weights and ration energy levels. It takes about five times as much feed to put on a pound of gain at 143 pounds liveweight than at 66 pounds (column 5 in tables 5 and 6. See also fig. 1.).

7/ Slaughter points were at day 87, 122, and 212 for the low- and medium-energy treatments and 59, 115, and 212 for the high-energy treatments. Data from the concurrent experiment, mentioned earlier, with its 5 slaughter dates, were included in the regressions for quality grade.

Table 3--Raw data on growth, feed consumption, and efficiency of rams and ewes on three ration energy levels, for various feeding periods 1/

Item	Rams: Low energy 2/	Rams: Medium energy	Rams: High energy	Ewes: Low energy	Ewes: Medium energy	Ewes: High energy
			Number			
Lambs	72	69	71	76	77	76
			Pounds			
Beginning weight 3/	49.4	48.9	48.9	47.8	47.2	48.1
Liveweight at day:						
30	71.0	75.6	77.8	65.3	67.9	69.4
58	85.1	88.2	93.3	75.4	78.9	80.5
86	99.6	100.5	108.2	86.9	88.2	90.4
114	117.7	121.3	126.5	101.2	103.2	102.5
142	129.0	130.7	132.1	112.7	113.8	113.3
170	135.4	136.7	137.6	119.0	116.8	117.5
212	147.0	155.4	153.7	134.7	132.9	135.1
Feed consumption to day:						
			Mcal ME			
30	104	116	118	104	107	105
58	234	240	242	220	221	217
86	369	366	366	335	330	321
114	534	514	514	477	451	436
142	695	649	637	617	575	552
170	855	790	766	767	699	673
212	1096	1009	992	971	885	872
Feed/gain to day:						
			Mcal ME/lb gain			
30	4.76	4.35	4.08	5.94	5.17	4.94
58	6.53	6.12	5.44	7.98	6.99	6.71
86	7.35	7.08	6.17	8.57	8.03	7.58
114	7.80	7.12	6.62	8.94	8.07	8.03
142	8.71	7.94	7.67	9.53	8.62	8.48
170	9.93	8.98	8.66	10.75	10.02	9.71
212	11.20	9.48	9.48	11.20	10.34	10.02

1/ Data are expressed as treatment means at successive weigh periods.
2/ Ration energy levels are described in table 1.
3/ Weight at beginning of feeding period.

Table 4--Coefficients for regressions on days on feed for growth, feed consumption, dressing percentage, and quality grade, by sex and ration energy level

Item	Rams			Ewes		
	Low energy 1/	Medium energy	High energy	Low energy	Medium energy	High energy
Number lambs	72	69	71	76	77	76
Growth (pounds) 2/						
"a" coefficient	18.333	19.984	23.061	16.960	19.881	21.018
"b" coefficient	.3887	.3765	.3517	.3792	.3476	.3379
r^2	.987	.975	.989	.974	.974	.974
Feed consumption (Mcal ME) 2/						
"a" coefficient	1.7076	2.6674	2.9382	2.0711	2.7305	2.7323
"b" coefficient	1.2099	1.1083	1.0859	1.1486	1.0791	1.0730
r^2	.999	.999	.999	.999	.999	.999
Dressing percentage 2/						
"a" coefficient	21.7280	27.5830	33.8690	25.2847	31.0718	34.2710
"b" coefficient	.1593	.122	.0888	.1329	.1004	.0893
r^2	.917	.952	.994	.882	.999	.939
Quality grade 2/						
"a" coefficient	4.2107	3.9209	3.8191	4.9089	4.3411	4.4404
"b" coefficient	.1933	.2213	.2350	.1742	.2096	.2063
r^2	.957	.968	.972	.988	.988	.977
Yield grade 3/						
"a" coefficient	1.8888	1.8888	1.8888	1.7112	1.7112	1.7112
"b" coefficient	.0041	.0041	.0041	.0086	.0086	.0086
r^2	.763	.743	.743	.872	.872	.872

1/ Low-energy, medium-energy, and high-energy rations contained 1.011, 1.106, and 1.298 Mcal ME per pound of dry matter, respectively.

2/ Observations are pen means of the items taken at periodic weigh periods and slaughter dates. Equations are exponential of the form $Y = aX^b$, where Y is the item of interest, X is days on feed, and "a" and "b" are the regression coefficients. Data were converted to logarithms to estimate these equations.

3/ The yield grade equation is linear of the form $Y = a + bX$, where Y is yield grade, X is days on feed, and "a" and "b" are regression coefficients.

Table 5--Feed consumption, efficiency, and cost for rams on low-, medium-, and high-energy rations

Live-weight	Days required 1/	Cum. feed 2/	Feed/gain: Cum. 4/	Feed/gain: Inst. 5/	Cumulative feed cost 3/: Low price	Cumulative feed cost 3/: Base price	Cumulative feed cost 3/: High price
lbs.	Days	Mcal ME	Mcal ME per lb		Dollars per lamb		
Low-energy ration:							
66	27	93	5.49	4.4	3.86	4.56	5.25
77	40	150	5.40	6.0	6.26	7.39	8.51
88	57	227	5.85	8.0	9.47	11.18	12.88
99	77	327	6.58	10.3	13.66	16.12	18.57
110	101	454	7.44	12.8	18.96	22.38	25.79
121	129	612	8.48	15.7	25.52	30.12	34.70
132	162	802	9.66	18.9	33.46	39.50	45.50
143	198	1028	10.93	22.4	42.92	50.66	58.36
154	240	1295	12.34	26.1	54.06	63.81	73.52
Medium-energy ration:							
66	24	90	5.21	4.0	3.63	4.38	5.10
77	36	142	5.03	5.4	5.72	6.90	8.04
88	52	211	5.35	7.0	8.48	10.22	11.91
99	71	298	5.94	8.8	11.98	14.45	16.83
110	93	407	6.62	10.8	16.35	19.71	22.96
121	120	538	7.44	13.1	21.63	26.07	30.38
132	151	696	8.35	15.5	27.95	33.70	39.27
143	187	880	9.30	18.1	35.37	42.64	49.68
154	228	1095	10.39	20.9	44.01	53.05	61.82
High-energy ration:							
66	20	76	4.40	3.5	2.55	3.35	3.98
77	31	122	4.22	4.9	4.10	5.40	6.40
88	45	185	4.72	6.5	6.19	8.15	9.67
99	63	266	5.31	8.3	8.90	11.72	13.90
110	86	368	5.99	10.3	12.34	16.24	19.27
121	112	494	6.85	12.6	16.56	21.80	25.86
132	144	646	7.76	15.1	21.65	28.50	33.82
143	180	827	8.75	17.8	27.73	36.50	43.30
154	223	1040	9.89	20.8	34.86	45.89	54.45

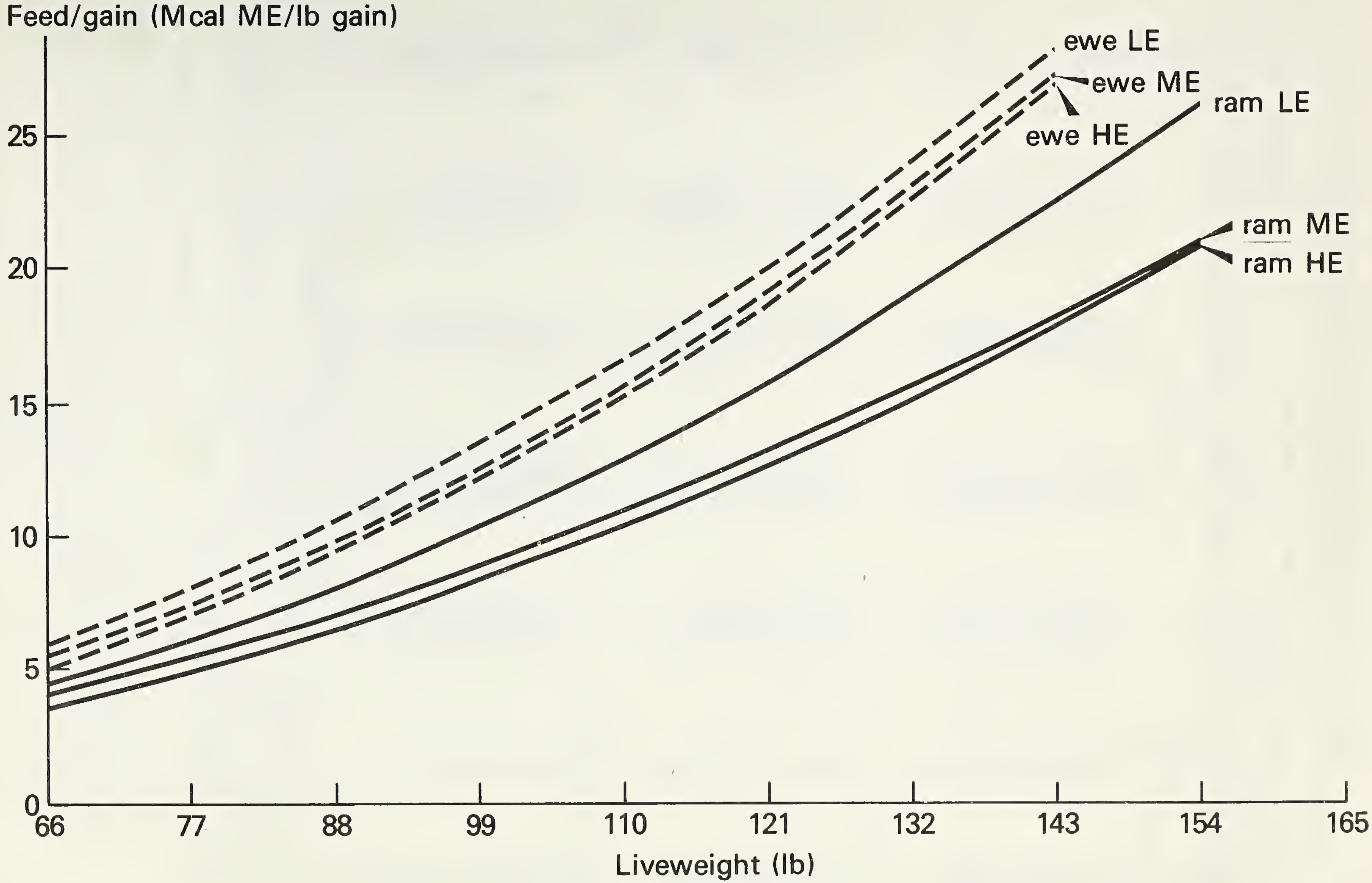
1/ Days on feed required to reach the weight indicated.
2/ Derived from equations in table 4.
3/ Assumes feed price levels displayed in table 2.
4/ Cumulative feed efficiency since the beginning of the feeding period.
5/ Instantaneous feed efficiency at each weight level is calculated as the first derivative of an equation expressing feed intake as a function of live-weight.

Table 6--Feed consumption, efficiency, and cost for ewes on low-, medium-, and high-energy rations

Live-weight	Days required 1/	Cum. feed 2/	Feed/gain Cum. 4/	Feed/gain Inst. 5/	Cumulative feed cost 3/ Low price	Cumulative feed cost 3/ Base price	Cumulative feed cost 3/ High price
lbs	Days	Mcal ME	Mcal ME per lb		Dollars per lamb		
Low-energy ration:							
66	36	128	7.0	5.9	5.33	6.30	7.25
77	54	204	6.9	8.0	8.50	10.03	11.55
88	77	305	7.6	10.5	12.75	15.05	17.34
99	105	436	8.5	13.3	18.20	21.49	24.75
110	139	600	9.6	16.5	25.05	29.57	34.07
121	179	801	10.9	20.0	33.44	39.48	45.48
132	225	1043	12.3	23.9	43.51	51.36	59.17
143	278	1329	13.9	28.1	55.47	65.48	75.44
Medium-energy ration:							
66	32	114	6.0	5.4	4.59	5.53	6.45
77	50	184	6.1	7.4	7.40	8.92	10.39
88	73	278	6.8	9.8	11.18	13.48	15.71
99	102	401	7.7	12.6	16.12	19.43	22.65
110	138	556	8.8	15.6	22.36	26.96	31.41
121	182	748	10.1	19.1	30.07	36.25	42.25
132	233	980	11.5	23.0	39.39	47.49	55.34
143	294	1257	13.1	27.2	50.50	60.88	70.95
High-energy ration:							
66	30	104	5.7	5.0	3.48	4.59	5.44
77	47	170	5.8	7.0	5.69	7.49	8.88
88	70	260	6.4	9.3	8.70	11.45	13.59
99	99	377	7.3	12.1	12.64	16.64	19.74
110	135	527	8.5	15.2	17.67	23.26	27.60
121	179	713	9.8	18.7	23.91	31.47	37.34
132	231	941	11.2	22.6	31.53	41.51	49.25
143	293	1213	12.7	26.9	40.65	53.51	63.49

1/ Days on feed required to reach the weight indicated.
2/ Derived from equations in table 4.
3/ Assumes feed price levels displayed in table 2.
4/ Cumulative feed efficiency since the beginning of the feeding period.
5/ Instantaneous feed efficiency at each weight level is calculated as the first derivative of an equation expressing feed intake as a function of liveweight.

Figure 1. Effect of liveweight on instantaneous feed efficiency for rams and ewes, by ration energy level



Source: Tables 5 and 6

Table 7--Value-determining characteristics and ram value for various pricing schemes, by ration energy level and liveweight

Liveweight	Days on feed 1/	Dressing percentage 2/	Quality grade 2/,3/	Yield grade 2/	Value per ram for lamb value scheme: B 4/	C 4/	D 4/
lbs	Days	Pct	Score		Dollars		
Low-energy level:							
66	27	36.74	7.97	2.00	23.62	21.75	21.75
77	40	39.16	8.60	2.05	29.46	27.67	27.67
88	57	41.36	9.20	2.12	35.60	33.97	33.97
99	77	43.40	9.75	2.20	42.06	40.67	40.67
110	101	45.31	10.27	2.30	48.83	47.75	47.71
121	129	47.12	10.77	2.41	55.94	55.24	52.98
132	162	48.83	11.25	2.54	63.28	63.01	58.55
143	198	50.46	11.71	2.69	70.88	71.11	64.45
154	240	52.01	12.15	2.86	78.71	79.51	70.65
Medium-energy level:							
66	24	40.72	7.92	2.00	26.25	24.36	24.36
77	36	42.82	8.68	2.05	32.29	30.55	30.55
88	52	44.72	9.38	2.12	38.56	37.06	37.06
99	71	46.47	10.05	2.20	45.11	43.96	43.96
110	93	48.09	10.70	2.30	51.89	51.18	51.14
121	120	49.60	11.31	2.41	58.95	58.77	56.51
132	151	51.03	11.91	2.54	66.19	66.62	62.16
143	187	52.37	12.48	2.69	73.61	74.73	68.07
154	228	53.65	13.04	2.86	81.24	83.14	74.28
High-energy level:							
66	20	44.19	7.72	2.00	28.55	26.55	26.55
77	31	45.95	8.56	2.05	34.70	32.88	32.88
88	45	47.52	9.36	2.12	41.03	39.52	39.52
99	63	48.96	10.12	2.20	47.58	46.48	46.48
110	86	50.28	10.87	2.30	54.31	53.75	53.71
121	112	51.51	11.58	2.41	61.27	61.35	59.09
132	144	52.65	12.27	2.54	68.33	69.14	64.68
143	180	53.73	12.95	2.69	75.76	77.22	70.56
154	223	54.74	13.60	2.86	82.92	85.51	76.65

1/ Days on feed required to reach the corresponding weight.

2/ Derived from equations in table 4.

3/ Quality grade scores are as follows: 9 = High Good, 10 = Low Choice, 11 = Medium Choice, etc.

4/ Lamb value schemes are as follows:

B $50.00/cwt adjusted by $1 for each dressing percentage below or above 51.

C $50.00/cwt adjusted as B and adjusted by $.80 for each quality grade unit below or above 11.5.

D $50.00/cwt adjusted as C and a reduction in value of $20 per cwt for weight in excess of 110 pounds.

Table 8--Value-determining characteristics and ewe value for various pricing schemes, by ration energy level and liveweight

Live-weight	Days on feed 1/	Dressing percent-age 2/	Quality grade 2/,3/	Yield grade 2/	Value per ram for lamb value scheme: B 4/	C 4/	D 4/
lbs	Days	Pct	Score		Dollars		
Low-energy level:							
66	36	40.74	9.17	2.02	26.27	25.04	25.04
77	54	42.99	9.84	2.18	32.42	31.39	31.39
88	77	45.06	10.47	2.38	38.86	38.13	38.13
99	105	46.96	11.05	2.62	45.59	45.23	45.23
110	139	48.72	11.60	2.91	53.69	53.78	53.74
121	179	50.38	12.12	3.26	61.11	61.71	59.45
132	225	51.94	12.61	3.66	67.39	68.56	64.10
143	278	53.42	13.08	4.11	75.12	76.93	70.27
Medium-energy level:							
66	32	43.97	8.96	2.02	28.40	27.06	27.06
77	50	45.97	9.84	2.18	34.72	33.69	33.69
88	73	47.77	10.66	2.38	41.25	40.66	40.66
99	102	49.42	11.44	2.62	49.02	48.97	48.97
110	138	50.95	12.19	2.91	55.04	55.65	55.61
121	182	52.37	12.92	3.26	62.31	63.69	61.43
132	233	53.71	13.61	3.66	69.74	71.97	67.51
143	294	54.96	14.29	4.11	77.32	80.52	73.86
High-energy level:							
66	30	46.40	8.94	2.02	30.01	28.66	28.66
77	47	48.33	9.82	2.18	36.54	35.50	35.50
88	70	50.07	10.66	2.38	43.28	42.69	42.69
99	99	51.65	11.45	2.62	50.24	50.20	50.20
110	135	53.11	12.22	2.91	57.43	58.10	58.06
121	179	54.47	12.95	3.26	64.86	66.27	64.01
132	231	55.74	13.65	3.66	72.42	74.70	70.24
143	293	56.93	14.34	4.11	80.15	83.41	76.75

1/ Days on feed required to reach the corresponding weight.
2/ Derived from equations in table 4.
3/ Quality grade scores are as follows: 9 = High Good, 10 = Low Choice, 11 = Medium Choice, etc.
4/ Lamb value schemes are described in footnote 4 of table 7.

Tables 5 and 6 also show the cumulative feed cost at each weight level under three alternative feed price assumptions.8/ Feed costs for both rams and ewes were lower for the high-energy rations for two reasons: (1) feed cost per megacalorie of metabolizable energy was less for the high-energy rations and (2) feed efficiency was improved for lambs under the high-energy rations.

Lamb Valuation

Results in table 7 for rams and table 8 for ewes show the values per lamb at their various weight levels and the factors entering into this value determination. Dressing percentage and quality and yield grades increase as weight of lambs increases, regardless of the sex or dietary treatment. But these factors increase relatively more under the high-energy rations than the low. Also, for each dietary level, dressing percentage and quality and yield grades are higher for ewe lambs than ram lambs at each weight level.

Results of this experiment show that ram lambs reached the Choice (score 10.0) quality grade at about 106, 98, and 97 pounds liveweight for the low-, medium-, and high-energy dietary levels, respectively (table 7). Ewe lambs reached Choice at about 79 pounds liveweight under all three rations, but they reached Prime (score 13.0) at about 141, 123, and 121 pounds liveweight for the low-, medium-, and high-energy levels, respectively (table 8).

Values per lamb reflect their weight, dressing percentage, quality grade levels, and the relative importance a buyer assigns to each of these items. Three lamb valuation schemes are shown in tables 7 and 8. In column B, only liveweight and dressing percentage are used as price determining factors; in column C quality grade was added; and in column D a discount was assumed for liveweights over 110 pounds.

Values per ewe at each weight level are $2 to $6 higher than values per ram in the same energy treatment because ewes have higher dressing percentages and quality grades. But, except at the very light weights, the saving in feed cost by rams due to higher feed efficiencies more than offsets the higher ewe values. This results in higher net returns for the rams. Nonfeed costs are also lower for the rams because they take less time in the feedlot to reach a given weight level.

Net Returns

Tables 9 and 10 combine feed and nonfeed costs and lamb values to derive net returns for rams and ewes at various weight levels and feed rations. These tables also show the weight levels at which profits are maximized (or losses minimized) for each of the three feed price assumptions and each of the three lamb valuation schemes.

8/ Feed price assumptions were shown in table 2.

Table 9--Net returns per ram lamb for various feed cost levels and lamb valuation schemes, by ration energy level and liveweight 1/

Live-weight	Days on feed	Lamb valuation scheme 2/: Low feed cost B	Low feed cost C	Low feed cost D	Baseline feed cost B	Baseline feed cost C	Baseline feed cost D	High feed cost B	High feed cost C	High feed cost D
lbs	Days	Dollars per ram								
Low-energy ration:										
66	27	-6.92	-8.79	-8.79	-7.62	-9.49	-9.49	-8.31	-10.18	-10.18
77	40	-4.04	-5.85	-5.85	-5.17	-6.98	-6.98	-6.29	-8.10	-8.10
88	57	-1.83	-3.46	-3.45	-3.54	-5.17	-5.17	-5.24	-6.87	-6.87
99	77	-.43	-1.82	-1.82	-2.89	-4.28	-4.28	-5.34	-6.73	-6.73
110	101	-.30	-1.08	-1.12	-3.72	-4.50	-4.55	-7.13	-7.91	-7.95
121	129	-.68	-1.38	-3.64	-5.28	-5.98	-8.24	-9.86	-10.56	-12.82
132	162	-2.65	-2.92	-7.38	-8.69	-8.96	-13.42	-14.69	-14.96	-19.42
143	198	-6.14	-5.91	-12.57	-13.88	-13.65	-20.31	-21.58	-21.35	-28.01
154	240	-11.25	-10.45	-19.31	-21.00	-20.20	-29.06	-30.71	-29.91	-38.77
Medium-energy ration:										
66	24	-3.92	-5.81	-5.81	-4.67	-6.56	-6.56	-5.39	-7.28	-7.28
77	36	-.51	-2.25	-2.25	-1.69	-3.43	-3.43	-2.83	-4.57	-4.57
88	52	2.35	.85	.85	.59	.89	.89	-1.10	-2.58	-2.58
99	71	4.59	3.44	3.44	2.12	.97	.97	-.26	-1.41	-1.41
110	93	5.98	5.27	5.23	2.62	1.91	1.87	-.63	-1.34	-1.38
121	120	6.62	6.44	4.18	2.18	2.00	-.26	-2.13	-2.31	-4.57
132	151	6.17	6.60	2.14	.42	.85	-3.61	-5.15	-4.72	-9.18
143	187	4.63	5.75	-.91	-2.64	-1.52	-8.18	-9.68	-8.56	-15.22
154	228	1.86	3.76	-5.10	-7.18	-5.28	-14.14	-15.95	-14.05	-22.91
High-energy ration:										
66	20	-.37	-2.37	-2.37	-1.12	-3.17	-3.17	-1.75	-3.80	-3.80
77	31	3.76	1.94	1.94	2.46	.64	.64	1.46	-.36	-.36
88	45	7.37	5.86	5.86	5.41	3.90	3.90	3.89	4.28	4.28
99	63	10.43	9.33	9.33	7.61	6.51	6.51	5.43	4.33	4.33
110	86	12.78	12.22	12.18	8.88	8.32	8.28	5.85	5.29	5.25
121	112	14.35	14.43	12.17	9.11	9.19	6.93	5.05	5.13	2.87
132	144	14.98	15.79	11.33	8.13	8.94	4.48	2.81	3.62	-.84
143	180	14.52	16.18	9.52	5.75	7.41	.75	-1.05	.61	-6.05
154	223	12.93	15.52	6.66	1.90	4.49	-4.37	-6.66	-4.07	-12.93

1/ Net returns per lamb at each weight level equal lamb value (table 7) minus lamb feeder cost ($23.00 per lamb) minus feed cost (table 5) minus $2.50 per lamb which represents veterinary, sales expenses, repairs, fuel, and miscellaneous minus $0.0433 times days on feed which represents labor, investment, and interest charges.

2/ Lamb value schemes are described in footnote 4 of table 7.

Note: Underlined number indicates the point at which highest net return (or lowest net loss) is achieved.

Table 10--Net returns per ewe lamb for various feed cost levels and lamb valuation schemes, by ration energy level and liveweight 1/

Live-weight	Days on feed	Lamb valuation scheme 2/								
		Low feed cost			Baseline feed cost			High feed cost		
		B	C	D	B	C	D	B	C	D
lbs	Days	Dollars per ewe								
Low-energy level:										
66	36	-6.14	-7.37	-7.37	-7.11	-8.34	-8.34	-8.06	-9.29	-9.29
77	54	-3.94	-4.97	-4.97	-5.47	-6.50	-6.50	-6.99	-8.02	-8.02
88	77	-2.74	-3.47	-3.47	-5.04	-5.77	-5.77	-7.33	-8.06	-8.06
99	105	-2.68	-3.04	-3.04	-5.97	-6.33	-6.33	-9.23	-9.59	-9.59
110	139	-2.90	-2.81	-2.85	-7.42	-7.33	-7.37	-11.92	-11.83	-11.87
121	179	-5.58	-4.98	-7.24	-11.62	-11.02	-13.28	-16.62	-16.02	-18.28
132	225	-11.37	-10.20	-14.66	-19.22	-18.05	-22.51	-27.03	-25.86	-30.32
143	278	-17.89	-16.08	-22.74	-27.90	-26.09	-32.75	-37.86	-36.05	-42.71
Medium-energy level:										
66	32	-3.05	-4.39	-4.39	-3.99	-5.33	-5.33	-4.91	-6.25	-6.25
77	50	-.31	-1.34	-1.34	-1.83	-2.86	-2.86	-3.30	-4.33	-4.33
88	73	1.44	.85	.85	-.86	-1.45	-1.45	-3.09	-3.68	-3.68
99	102	2.99	2.94	2.94	-.32	-.37	-.37	-3.54	-3.59	-3.59
110	138	1.20	1.81	1.77	-3.40	-2.79	-2.83	-7.85	-7.24	-7.28
121	182	-1.11	.27	-1.99	-7.29	-5.91	-8.17	-13.28	-11.90	-14.16
132	233	-5.25	-3.02	-7.48	-13.35	-11.12	-15.58	-21.20	-18.97	-23.43
143	294	-11.39	-8.19	-14.85	-21.77	-18.57	-25.23	-31.84	-28.64	-35.30
High-energy level:										
66	30	-.23	-1.58	-1.58	-1.34	-2.69	-2.69	-2.19	-3.54	-3.54
77	47	3.32	2.28	2.28	1.52	.48	.48	.13	-.91	-.91
88	70	6.07	5.48	5.48	3.32	2.73	2.73	1.18	.59	.59
99	99	7.83	7.79	7.79	3.83	3.79	3.79	.73	.69	.69
110	135	8.42	9.09	9.05	2.83	3.50	3.46	-1.51	-.84	-.88
121	179	7.71	9.12	6.86	-.85	.56	-1.70	-5.72	-4.31	-6.57
132	231	5.36	7.64	3.18	-4.62	-2.34	-6.80	-12.36	-10.08	-14.54
143	293	1.29	4.55	-2.11	-11.57	-8.31	-14.97	-21.55	-18.29	-24.95

1/ Net returns per lamb at each weight level equal lamb value (table 8) minus lamb feeder cost ($23.00 per lamb) minus feed cost (table 6) minus $2.50 per lamb which represents veterinary, sales expenses, repairs, fuel, and miscellaneous minus $0.0433 times days on feed which represents labor, investment, and interest charges.

2/ Lamb value schemes are described in footnote 4 of table 7.

Note: Underlined number indicates the point at which highest net return (or lowest net loss) is achieved.

Profits were higher for ram than ewe lambs for all ration energy treatments and for all weight levels above 77 pounds. The high-energy level resulted in larger profits for both sexes. The rams were able to utilize the high-energy rations more efficiently than the ewes. Neither sex generated a profit at the low-energy ration, even assuming low feed prices. At baseline feed prices, the ewes were profitable only under the high-energy ration.

Weights at which highest net returns were obtained were affected by energy level, sex, feed cost level, and lamb valuation scheme. In general, the higher the ration energy density, the higher the weights at which profits could be obtained (tables 9 and 10, fig. 2). Under baseline and low feed prices and the high-energy ration, profits were obtained for rams weighing as high as 154 pounds 9/; profits, however, were maximized at lower weights.

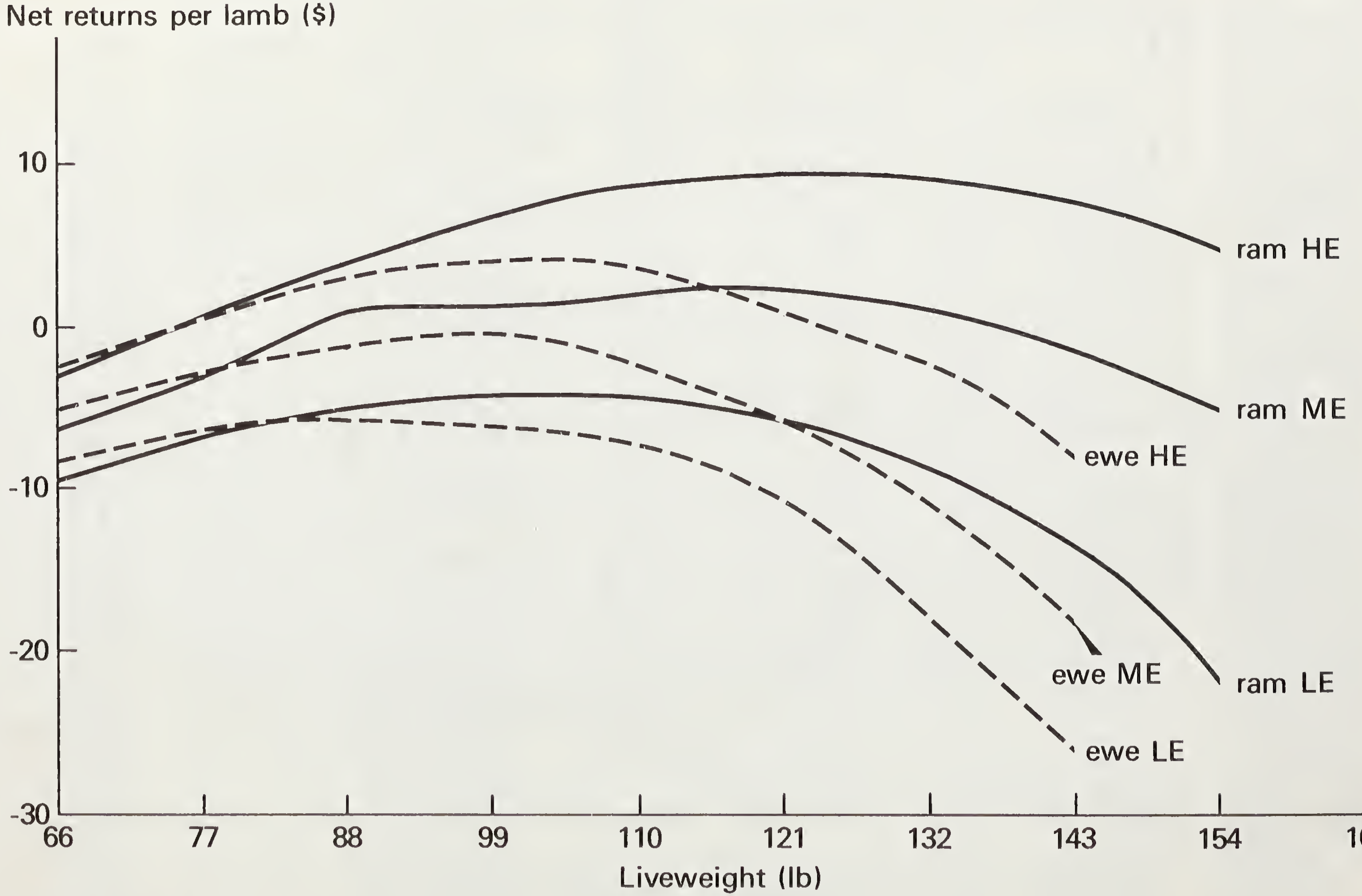
Ram weights at the point of maximum profits (assuming no discount due to heavy weights) were at 110, 121, and 143 pounds assuming high, baseline, and low feed prices, respectively. Normal slaughter weights in the industry for market lambs are between 90 and 110 pounds. A conclusion, then, is that ram lambs could be profitably carried to weights 10 to 40 pounds heavier than at present in the industry, depending upon the feed ration, the level of feed prices, and whether there is a discount for above-normal weights. Even at high feed price levels, optimal weights for rams are at the upper end of the normal industry slaughter weight range. Ewe weights at their point of maximum profits were 99, 99, and 121 pounds with high, baseline, and low feed prices, respectively.

The data in tables 8 and 9 show that if there is a price discount for weights above 110 pounds (scheme D), optimal slaughter weights do not exceed that level. However, positive net returns can still be obtained at heavier weights. Thus, price discounts for heavy weights represent a severe limiting factor in lamb production.

As shown above, the effect of higher feed costs is to reduce the optimal weight at which lambs should be marketed. And the effect of discounting lamb prices when weights exceed the normal industry range is to severely lower profits of producers and reduce the optimal slaughter weights. Higher or lower lamb prices, though not shown on the accompanying tables, would affect the level of producer profits, but have little effect on the optimal slaughter weight or feed ration.

9/ It should be recognized that rams weighing above 135 pounds have a probability of offensive odor which could severely reduce their value.

Figure 2. Net returns per lamb as liveweight changes, rams and ewes, by energy ration, assuming baseline costs and valuation scheme C



Source: Tables 9 and 10

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